# 2.0 AN OVERVIEW OF HANFORD TANK WASTE OPERATION SIMULATOR

This section has been included to provide a generic overview of how information is used by the HTWOS model to obtain results and prepare the TFC O&UP.

## 2.1 ASSEMBLING CONSTRAINTS, REQUIREMENTS, AND ASSUMPTIONS

Changes to the baseline drivers are identified by reviewing key documents against past assumptions. Examples of the documents or information that are reviewed include the following:

- DOE-ORP planning guidance
- Project schedules
- Operations plans and schedules
- Characterization data (best-basis inventory [BBI])
- BNFL Inc. process data
- *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1996) Milestone Schedules.

Changes to requirements are identified by the authors of this document and incorporated into the HTWOS model and Appendix A. Management and technical personnel are consulted when necessary to obtain clarification or to resolve conflicts. Appropriate technical and management review of the changes is obtained to confirm the accuracy of the changes. Any outstanding issues that are identified are communicated to management for resolution. The final requirements and assumptions are used to define the constraints in the HTWOS model and the scenarios simulated using the model.

## 2.2 INVENTORY BASIS (USE OF UPDATED BEST-BASIS INVENTORY, HISTORY UPDATING)

The HTWOS inventory for both the SST and DSTs was updated on January 25, 2000. This inventory estimate represents waste in the tanks as of October 1, 1999. The updated inventory is being used in the modeling of the 3S6 cases. Sections 2.2 and 2.3 explain how the HTWOS model calculated the DST inventory using the BBI data. Step numbers corresponding to those in Figure 2.2-1 will be shown in the descriptive text below, in brackets: **<example>**

The data for the HTWOS inventory used in the modeling of case 3S6E were gathered from the BBI summary and calculation detail reports as of January 11, 2000. The BBI data included waste transfer updates through October 1, 1999, for 175 of the 177 tanks. The two exceptions, 241-C-106 and 241-AY-102, included transfers only through July 31, 1999. A number of sources supplied data to the BBI. The first sources supplied sample data, **<i>**, gathered from tank samples. The second supplied process knowledge about what was put into or taken from the tank at different times **<ii>**. Process knowledge includes recent tank transfers, flowsheet estimates, and data for similar wastes in other tanks. The third supplied Hanford Defined Waste (HDW) model data, **<iii>**, which were based on historical waste transfers. Engineering evaluations determined which data source was most appropriate to use for calculation of the tank inventory. In general, sample data were the preferred source.

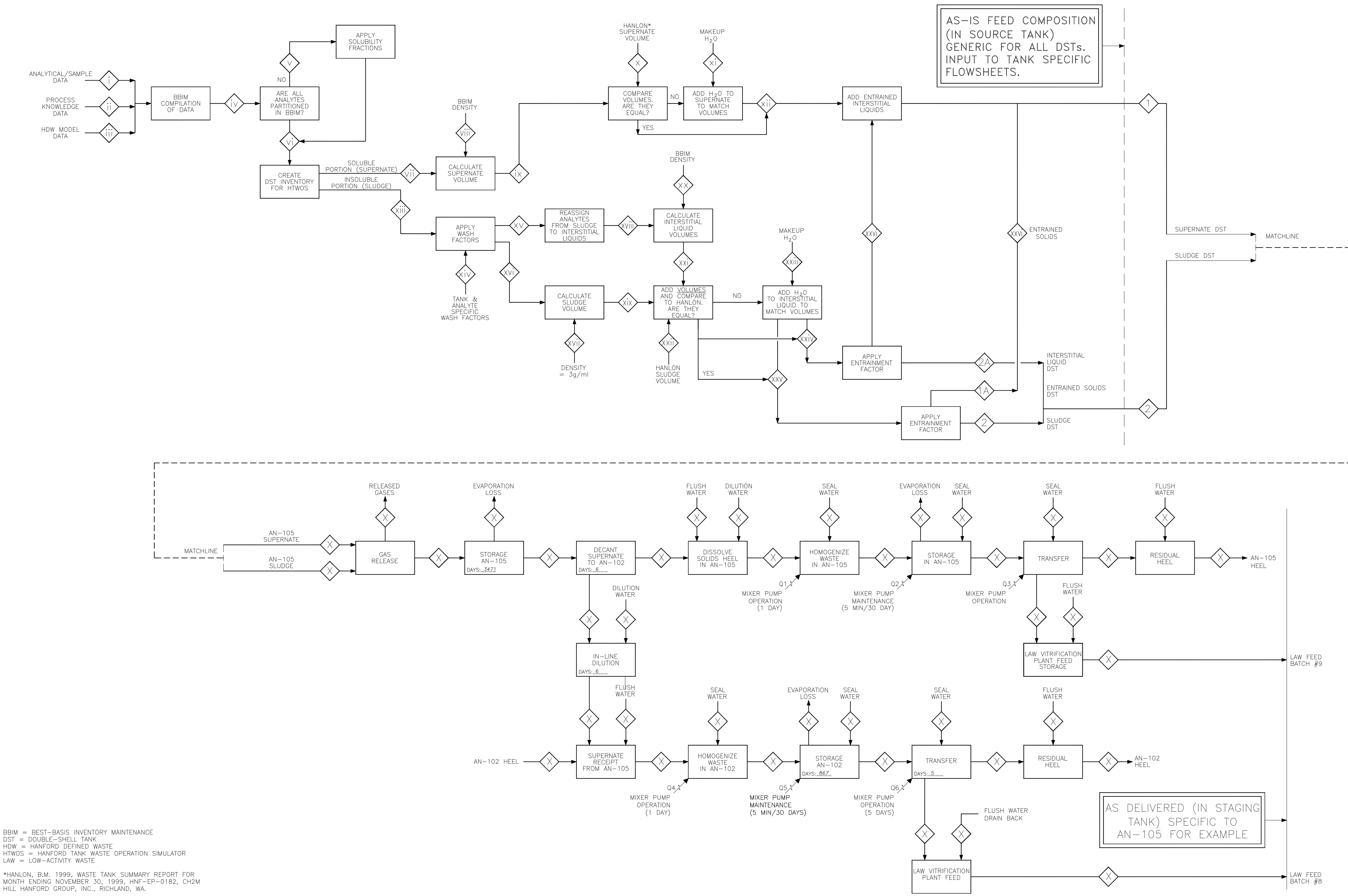
The Best-Basis Inventory Maintenance (BBIM) tool, a database, **<iv>**, compiled and documented the data from the sources mentioned above and calculated inventories for each analyte. These inventories were reported in the BBI. For the DSTs, the data were split by the BBIM as supernatant/drainable liquid and sludge/slurry/solids/saltcake. A few radionuclides and analytes were reported only as tank totals for the DSTs. In these cases, tank- and analyte-specific solubility factors, if available, were applied to the data to partition the analytes into soluble and insoluble fractions **<v>**. When solubility factors were unavailable, a general solubility rule was applied. This general rule was that $^{3}H$, $^{14}C$, $^{79}Se$, $^{99}Tc$, $^{129}I$, $^{134}Cs$, $^{137}Cs$, $^{137m}Ba$, Cl, $CO_3$, F, K, Na, $NO_2$, $NO_3$, $PO_4$, $SO_4$, and TOC are all completely soluble. Everything else was considered completely insoluble.

The U-Total value reported by the BBI included isotopic uranium in the inventory. For the HTWOS inventory, isotopic uranium was subtracted from the BBI U-Total value, leaving the remainder to be called UTOTAL. If the HTWOS UTOTAL calculation resulted in a value less than 0 kg, the inventory was set to zero. Free hydroxide values were reported in the BBI as charge balance calculations as opposed to sample values. This information was not useful to the HTWOS inventory. Free hydroxide values, based on sample data, were found in the BBIM for some tanks. When no sample data were available for the free hydroxide, a generic rule was assigned to calculate the free and bound hydroxide. For the supernatant (soluble) layer, this rule was (Free OH) = 0.9*(OH TOTAL). For the sludge (insoluble) layer, the rule was (Free OH) = 0.1*(OH TOTAL). Bound hydroxide was then calculated by subtracting the free hydroxide from the OH TOTAL reported by the BBI. The BBIM and partitioned information were copied directly into the DST inventory used by HTWOS, with the liquids being referred to as soluble and solids as insoluble layers **<vi>**.

For the SSTs, the HTWOS inventory data were also imported from the BBI. The SST BBI is being updated to include liquid and solid fractions. However, this effort has been completed only for a nominal number of tanks. When liquid/solid data were available, they were incorporated into the HTWOS SST inventory as such. Five of the SSTs to be saltwell pumped did not have liquid/solid phase information available through the BBI as of October 1, 1999. This issue was resolved by applying a combination of Environmental Simulation Program (ESP[1]) results, HDW model data, and analytical calculations to the BBI data for these tanks. The remainder of the SSTs were reported in the HTWOS inventory as having the analytes in the solid phase.

[1]ESP is a trademark of OLI Systems, Inc.

Figure 2.2-1. Hanford Tank Waste Operation Simulator Calculation Flowsheet for Generic Double-Shell Tank.




BBIM = BEST-BASIS INVENTORY MAINTENANCE
DST = DOUBLE-SHELL TANK
HDW = HANFORD DEFINED WASTE
HTWOS = HANFORD TANK WASTE OPERATION SIMULATOR
LAW = LOW-ACTIVITY WASTE

*HANLON, B.M. 1999, WASTE TANK SUMMARY REPORT FOR MONTH ENDING NOVEMBER 30, 1999, HNF-EP-0182, CH2M HILL HANFORD GROUP, INC., RICHLAND, WA.

The inventory and solid and liquid fractions for the cyanide ion (derived from the ferrocyanide ion) and ammonia were provided by the HDW model using the HDW model's Tank Layer Model (TLM) and Supernatant Mixing Model (SMM) calculation methods. The SMM included saltcake as well as liquid. The SMM values were considered to be soluble; the TLM values were considered insoluble.

## 2.3 LIQUID SOLID DISTRIBUTION

Once the DST data are imported into HTWOS, **<vi>**, the model takes the soluble portion of the inventory, **<vii>**, uses the BBIM density given for the supernate, **<viii>**, and calculates a supernate volume, **<ix>**. The model also imports the Hanlon (1999b) supernatant volume for the tank, **<x>**, which is then compared to the calculated volume. If these volumes are not the same, makeup water is adjusted, **<xi>**, in the supernate layer to make them equal, resulting in stream **<xii>**. If they are the same, no action is taken. To the sludge layer, **<xii>**, the model applies what is known as a wash factor, **<xiv>**. The wash factors are tank and analyte specific and were derived by Hendrickson (1998) from compilations of available analytical data and ESP[2] predictions. This factor reassigns a portion, **<xv>**, of the sludge layer into an interstitial liquid layer, **<xviii>**, associated with the sludge. This interstitial liquid layer does not mix with the supernate layer until retrieval. The composition of the interstitial liquid layer is not necessarily the same as that of the supernatant layer in the tank. The wash factor assumes that all dissolvable material originally in the sludge layer gets assigned to the interstitial liquids. During retrieval and dilution, no more material will be dissolved by the model.

At this point, the model takes the sludge layer, **<xvi>**, and calculates a sludge volume, **<xix>**, using the assumed density of 3 g/mL, **<xvii>**. A BBIM density, **<xx>**, is used to calculate a volume for the interstitial liquid layer, **<xxi>**. These two values are added and compared to the Hanlon sludge volume, **<xxii>**. If the volumes are not equal, makeup water, **<xxiii>**, is adjusted in the interstitial liquid layer, resulting in the interstitial liquid stream **<xxiv>**. Otherwise, no action is taken. The inventory for the sludge layer, **<xxv>**, does not change, regardless of whether the volumes are equal. The model then applies an entrainment factor to both the interstitial liquids and the sludge. This entrainment is applied to the sludge until solids constitute ½ weight percent of the supernate. Entrained interstitial liquids, **<xxvi>**, are added to the tank supernate. This addition results in the as-is tank supernatant stream, **<1>**, as recognized by HTWOS. The entrained solids, **<1A>**, sludge, **<2>**, and interstitial liquids, **<2A>**, are also now the as-is feed compositions for the DST. These four streams comprise the initial conditions used by the tank-specific flowsheets (see Sections 3.3 and 4.3) and HTWOS to calculate the as-delivered inventories.

When the SST inventory is imported by HTWOS, it brings along tank- and analyte-specific wash factors, as well as a required volume of water to be added for retrieval. At the time of retrieval, the additional water is added to the tank. The quantity of water added is just enough to result in a mixture that is less than or equal to 5*M* sodium and 10 wt% solids concentration. The wash factors are applied in a similar manner to those for the DSTs, in which they assign a portion of the solids layer into the retrieval water.

[2]ESP is a trademark of OLI Systems, Inc.

The wash factors reported by Hendrickson may not adequately represent the physical occurrences in the tanks during retrieval. Basic chemistry predicts that the salt layers, included in the insoluble portion of the initial DST splits, will dissolve after supernates are retrieved and fresh diluent is added. Therefore, wash factors being re-defined for Phase 1 tanks use the DST and SST inventories, the thermodynamic package ESP,[3] and available process test data as part of the tank-specific flowsheet effort. Once completed, there should be at least two sets of wash factors that can be considered as-is factors to report the actual tank conditions for most sludge-bearing Phase 1 tanks. One set would determine the amount of analytes in the interstitial liquid layer. The second would specify the fraction of solids that would dissolve on dilution by water or caustic addition.

The process steps documented in the tank-specific flowsheets will coincide with those performed by the HTWOS model. As tank-specific flowsheets are developed, various data inputs are used, including the HTWOS initial inventories and HTWOS projected inventories for tank retrievals happening in the far future. Tank-specific flowsheet effort results may need to be fed back to HTWOS, with the data being worked iteratively between the two models (HTWOS and ESP) until the as-delivered feed compositions to BNFL Inc. are reconciled. New ESP wash factors should better predict the amount of solids able to be dissolved for retrieval and will replace the wash factors now used in HTWOS. Laboratory process tests also may offer some improved wash factors for certain tanks.

## 2.4 INTEGRATION WITH OPERATIONS/OPERATIONS WASTE VOLUME PROJECTION

Retrieval Engineering maintains an interface with Process Engineering as the main source for near-term operational plans and for long-term waste generation plans. Data from the most recent Operational Waste Volume Projection (OWVP) document are used as input. Retrieval Engineering personnel work with Process Engineering personnel to identify changes in the plans or data, and Process Engineering personnel are involved in reviews of bases and assumptions, staging plans, use of DSTs, etc., before scenarios are simulated with the HTWOS model. Data are shared electronically between the two organizations to facilitate the information exchange and minimize errors. Process Engineering personnel also are involved in reviews of the results from the model and as contributors to the final document. The same modeling activity and use definition now support both the TFC O&UP and the OWVP.

## 2.5 RATIONALE FOR SOURCE TANK SELECTION

DOE-ORP provided the guidance for the selection of specific source tanks and the delivery sequence (PIO 2000). Their direction is based on past work that has tried to identify. Several generic rationales for source tank selection are applicable in addition to those specific to LAW and HLW feed delivery. Waste that is easy to retrieve, easy for BNFL Inc. to process, resolves storage safety issue by its retrieval, decreases storage risk by its retrieval because of its high radionuclide content, and frees up DST space by its retrieval. Furthermore, retrieving waste tanks in the same tank farm would simplify design and construction activities associated with Projects W-211 and W-521.

[3]ESP is a trademark of OLI Systems, Inc.

Three LAW feed envelopes, A, B, and C, and one HLW envelope, D, are established by the privatization contract (RL 1996). Each envelope provides a different technical challenge for BNFL Inc. Each DST was examined for chemical and radionuclide composition to determine the envelope classification of waste. Six tanks (241-AP-101, 241-AW-101, 241-SY-101, and 241-AN-103, -104 and -105) contain Envelope A feed; two tanks (241-AN-102 and –107) contain Envelope C feed; and two tanks (241-AZ-101 and 241-AZ-102) contain Envelope B feed to meet minimum order quantities during Phase 1. Tanks with high quality projections, including waste that is static, are delivered earlier in the sequence. Tanks with a large amount of sodium that can be easily retrieved were selected to be first. The source tanks that contained significant quantities of insoluble solids that can cause difficulty in retrieving the waste were neglected.

Six tanks (241-AZ-101, 241-AZ-102, 241-AY-102, 241-AY-101, 241-C-104 and 241-SY-102) contain Envelope D feed to meet minimum order quantities during Phase 1. Tanks that contain waste with high concentrations of radionuclides and that contain waste that is static are delivered earlier in the sequence (241-AZ-101, 241-AZ-102, 241-AY-102, and 241-AY-101). Tanks with a large amount of sludge that can be easily retrieved were selected for early delivery (241-AY-102 and 241-C-104). Tanks that have strategic operations functions as a result of waste compatibility issues are delivered in the minimum order quantity (241-SY-102). Potential source tanks that contain significant quantities of soluble solids that provide very little insoluble feed were neglected as an HLW feed source.

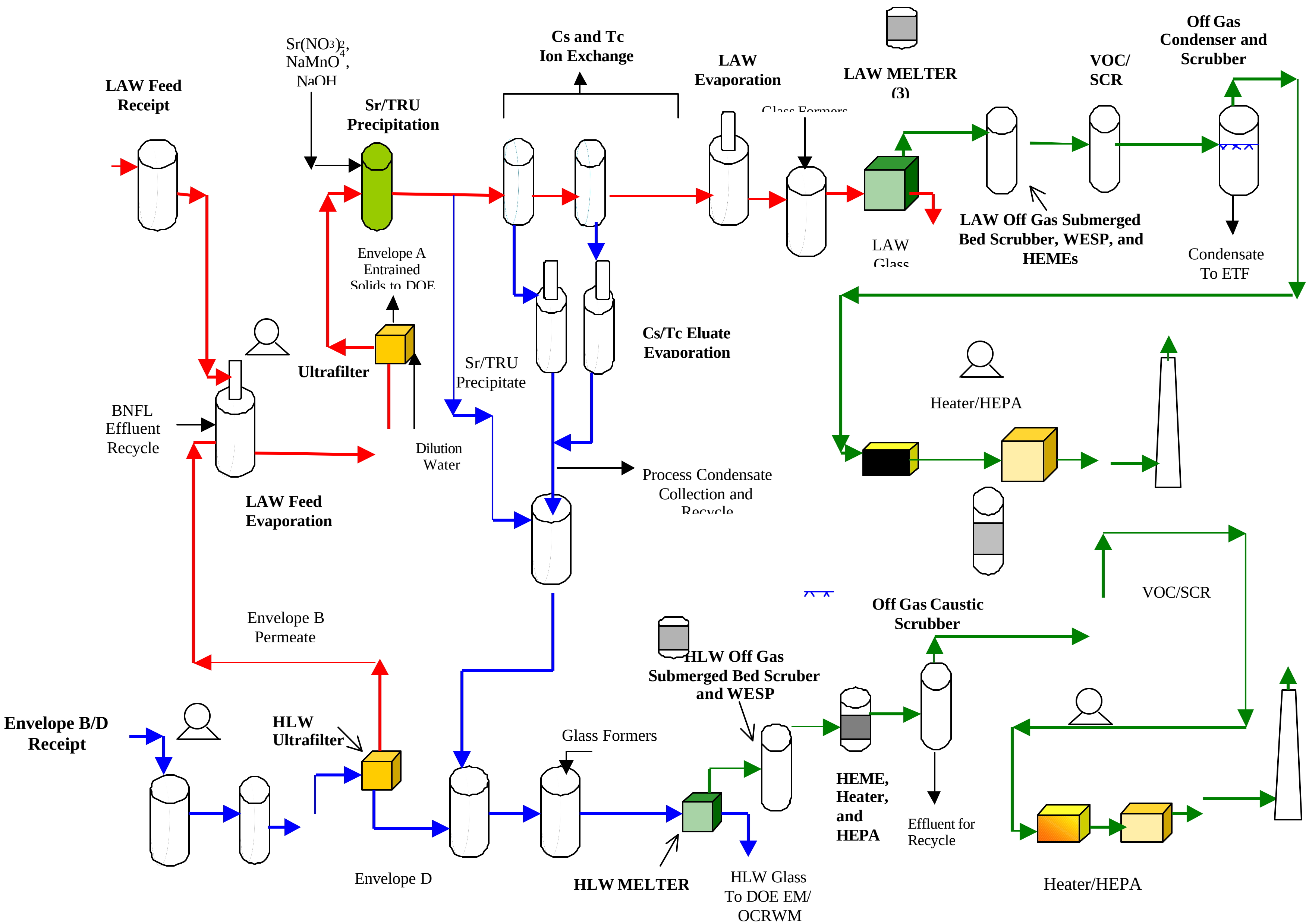
## 2.6 STAGING TANK SELECTION LOW-ACTIVITY WASTE

The staging approach for Case 3S6E is to provide reliable LAW feed delivery to BNFL Inc. while meeting privatization contract requirements. The number and location of staging tanks improves the reliability of LAW feed delivery by providing backup staged feed capability from independent tanks farms. Feed staging capability is provided from AN and AP tank farms to minimize the probability of a single-point failure in the delivery system resulting in loss of feed capability. Tanks 241-AN-101, 241-AN-102, and 241-AP-104 will be used initially as LAW staging tanks. Tank 241-AP-102 is a backup staging tank. Other tanks are to be used for staging feed as they become available.

## 2.7 TRANSURANIC, STRONTIUM, CESIUM, AND TECHNETIUM SEPARATION FROM LOW-ACTIVITY WASTE

The liquid fraction of Waste Treatment Plant (WTP) feeds (LAW) contains many radioisotopes. The WTP has provisions for separating only a few: transuranic (TRU), strontium, cesium, and technetium. A simple flowsheet of BNFL Inc.'s process is provided in Figure 2.7-1.

Figure 2.7-1.  Summary BNFL Inc. Flowsheet.



The WTP adds $NaMnO_4$ to Envelope C waste that is too high in aqueous TRU. Permanganate attacks complexants and releases complexed TRU, which then coprecipitates with the $MnO_2$ reaction product. Feeds that are too high in aqueous $^{90}Sr$ are treated with a $Sr(NO_3)_2$ addition. This treatment works by isotopic dilution and by exploiting the high carbonate concentration of Envelope C to precipitate $SrCO_3$. The following factors are used in HTWOS to account for the material balance effect of the TRU/strontium separation:

- 1*M* of manganese per 100*M* of waste sodium, and
- 1.5*M* of strontium per 100*M* of waste sodium.

Envelope A, Envelope B, and the treated Envelope C (see previous paragraph) are clarified through ultrafiltration.

Clarification of Envelope B discharges Envelope D HLW solids. The entrained solids discharged from Envelope A and C are handled in different ways depending on the case. BNFL Inc. will separate the entrained solids and the TRU/strontium precipitates using different process steps. It may blend them together into the HLW glass depending on incentives provided by DOE. Case 3S6E segregates entrained solids from the TRU/strontium precipitates that become HLW feed. In other cases, TRU/strontium precipitates with entrained solids become HLW feed.

The ultrafiltration permeate goes on to cesium ion exchange. BNFL Inc. has selected a regenerable ion exchange process that consumes caustic, nitric acid, and ion exchange resin.

Cesium-depleted effluent goes on to technetium removal. A regenerable adsorption process has been selected. Aqueous technetium is assumed to be in the form of $TcO_4^-$, and $NaTcO_4$/$KTcO_4$ load onto the resin. This process also consumes caustic, nitric acid, and the adsorption medium.

The cesium concentrate from ion exchange and the technetium product are worked off as feeds into HLW treatment.

The authority for the above separations is derived from DOE Order 435.1, *Radioactive Waste Management*. The order allows HLW waste originating from fuel reprocessing to be designated as waste incidental to reprocessing (WIR)[4] subject to the following conditions.

- Key radionuclides have been removed to the maximum extent technically and economically practical.

- Safety - disposal performance objectives are met comparable to10 CFR Part 61, Subpart C.

[4]In the context of privatization, treated LAW feeds are ILAW, and ILAW is equivalent to WIR.

- Immobilized solid waste form does not exceed concentration limits for Class C waste (10 CFR 61.55) or alternative requirements.

Waste recognized as WIR need not be managed as HLW and is suitable for near-surface disposal. WIR principles have been applied to privatization so that the greater part of the caustic-soluble chemical inventory can be solidified for onsite disposal and most of the caustic-insoluble/radioactive inventory goes to the HLW repository.

Separations requirements are not stated explicitly in the privatization contract. The "technically and economically practical" and safe disposal criteria have been translated into objective product requirements that are more stringent than Class C, namely

- $^{90}Sr$ may not be more than 20 $Ci/m^3$ in the ILAW.
- $^{137}Cs$ may not be more than 3 $Ci/m^3$ in the ILAW.
- $^{99}Tc$ may not be more than 0.1 $Ci/m^3$ in the ILAW.

These three limits are applied on a running average. Individual packages may exceed the limits as long as the average for total ILAW production complies. In addition, the radionuclide profile of each ILAW package must qualify for a Class C designation. More than 100 nCi/g TRU (alpha-emitting, >5-year half-life) in the ILAW disqualifies the product from Class C consideration.

The radionuclide separations are modeled in HTWOS at a rudimentary level. HTWOS accounts for chemical additions (such as manganese and strontium) that have an effect on IHLW production. However, some chemical additions that affect total sodium are absent from the model. As noted above, WTP's cesium and technetium separations add chemicals to the waste, the net effect of which is to increase the $NaNO_3$ and water in the feed to LAW vitrification. These chemical additions are not tracked. Consequently, HTWOS under-projects the total ILAW.[5]

## 2.8 HIGH-LEVEL WASTE WASHING

To prepare HLW feeds for immobilization in Phase 1, BNFL Inc. will separate sludge into HLW and LAW fractions using a separation process referred to as sludge washing. The purpose of sludge washing is to minimize the amount of material for HLW immobilization by dissolving and removing primarily non-radioactive chemicals from the HLW feeds.

Caustic washing, sometimes referred to as caustic leaching, is performed by adding sodium hydroxide solution to the waste and mixing to dissolve caustic soluble compounds. Separation of large fractions of aluminum, present as gibbsite, as well as

[5] CHG is building the WTP flowsheet into the next generation of the HTWOS model. This "integrated flowsheet" will address WTP operations in a much higher level of detail. The only Na addition currently tracked in HTWOS is that required for caustic leaching.

other non-radioactive chemicals from tank sludge, has been successfully demonstrated. The caustic leach solution is washed from the sludge with very dilute caustic wash water.

Sludge washing without caustic leaching (sometimes referred to as dilute caustic washing or water washing) represents the minimum pretreatment for HLW sludge. It is performed by initially separating the transport fluid from the solids. The solids then are washed with a very dilute caustic solution to remove the water-soluble components from the sludge, mainly sodium salts. Wash solutions from both washing processes become part of the LAW feed.

Additional LAW glass is produced as a result of the added and leached sodium in the wash solutions. Caustic leach and water wash tests will be performed by BNFL Inc. on sludge samples from each HLW staging tank to determine the most cost effective washing process by comparing the amount of HLW and LAW glass that would be produced.

An initial comparison by BNFL indicated that water washing is most cost effective for tanks 241-AZ-101 and 241-AZ-102, but that caustic leaching is most cost effective for other minimum order HLW tanks. At this point, caustic leaching also is assumed to be the most cost effective for the remaining HLW tanks.

## 2.9 LOW-ACTIVITY WASTE PRODUCT VOLUMES (DRIVEN BY 20 PERCENT $Na_2O$)

The estimated volume of LAW glass is generally controlled by the amount of sodium oxide ($Na_2O$) in the glass. Three different composition envelopes have been defined for LAW waste. Envelope A consists of LAW wastes that fall into the normal composition range where sodium (and more specifically the leachability properties of sodium) control the composition of the glass. Envelope B initially was developed to represent a more challenging range of compositions characterized by high Cl, $PO_4$ and $SO_4$ content. Envelope C encompasses all of the LAW wastes with high organic content. The target compositions for ILAW produced from Envelope A, B, and C feeds in the Phase 1 vitrification contract are 19.5 percent, 7.5 percent, and 17 wt% $Na_2O$, respectively. These limits are used in the HTWOS model to estimate the volume of LAW glass that can be produced from each batch of LAW.

## 2.10 HIGH-LEVEL WASTE GLASS VOLUME (DRIVEN BY Cr, Zr, Fe, Al, $PO_4$)

The HTWOS model uses the glass property models (GPM) developed by the Pacific Northwest National Laboratory (PNNL) to estimate the volume of HLW glass. The GPM is used to determine the expected composition of the HLW glass at the defined operating limits for the melter and at the specified limits for the IHLW product. These limits are normally expressed or defined in terms of the limiting glass properties for the HLW glass. The most important glass properties are viscosity, electrical conductivity, liquidus temperature, and sodium product consistency test (PCT) release. The PCT was developed to measure the durability and general quality of the IHLW product. The most critical property, aside from PCT, is usually the liquidus temperature of the glass. This temperature is defined as the temperature where the first crystals tend to precipitate in the molten glass. This condition is important because crystals might settle and cause sludge-forming conditions in the melter. If these conditions were to occur over a long period of time, they could easily affect the performance and operability of the melter. The GPM therefore can be used to estimate the limiting composition of the HLW glass, the corresponding waste oxide loading, and the minimum volume of HLW glass that can be produced from each batch of HLW.

The GPM appears to be generally reliable for estimating the properties of HLW glass (if the component concentrations fall within the defined composition limits of the models). The GPM may not be accurate for HLW glasses currently being developed by the vitrification contractor. These glasses typically contain only 32 to 33 percent $SiO_2$, compared to 42 to 57 percent $SiO_2$ in the glasses that were used to develop the GPM models. This difference appears to be relatively unimportant for reliable estimates of viscosity, electrical conductivity and PCT performance, but significant discrepancies may occur when the GPM is used for estimating the liquidus temperature of low $SiO_2$ glasses. This issue is important because it can lead to overly conservative estimates with the HTWOS model (predicting glass volumes that may be higher than the actual volume produced from certain wastes).

Fe, Cr, and Ni are often the limiting components in the waste because of their combined effect on the liquidus temperature of the glass. These components tend to form metal oxide crystals (or spinel) and thus limit the allowable waste oxide loading of the glass. Zirconium may be another limiting component if zircon (zirconium silicate) or zirconia (zirconium oxide) precipitate because the zirconium concentration is too high. Other components such as Al have a more complicated effect. Aluminum tends to improve the durability of the glass (as measured by the sodium PCT release), but also increases the viscosity and liquidus temperature of the glass. Aluminum also can affect the solubility limit for $PO_4$ in the glass. Because of these combined affects, Al can become the limiting component if caustic sludge washing processes are not used to remove excessive amounts of Al. Sulfate and $PO_4$ are sometimes the limiting components (at high concentration) because these impurities can separate and form a molten salt layer on top of the glass. This salt layer is highly corrosive to the refractory lining in the melter. Other compositions also need to be excluded from the allowable composition space because of the possibility of precipitating nepheline (sodium aluminum silicate) in the glass. When nepheline is formed, the durability of the glass may be reduced because of the corresponding depletion of Al. Most of the glass formulation problems that have been described are ones that usually can be solved by diluting the waste with inert glass formers (and reducing the waste oxide loading of the glass). However, such dilution also increases the volume and final disposal costs for the IHLW product.

## 2.11 SINGLE-SHELL TANK RETRIEVAL

The proposed sequence for retrieving SSTs is based on the logic developed in the *Single-Shell Tank Retrieval Program Mission Analysis Report* (MAR) (Stokes 1998). The SST Retrieval Program MAR suggests that CHG and DOE-ORP pursue a SST waste retrieval sequence that in the early waste retrievals focuses on sound saltcake tanks. Risk is reduced early in the mission by retrieving waste that has high levels of $^{99}Tc$. These tanks should provide plenty of material for LAW feed. After reducing the $^{99}Tc$ risk in sound saltcake SSTs, then retrieval should proceed to sludge-containing sound SSTs, followed by sound saltcake tanks with lower levels of $^{99}Tc$, and then sound tanks with a mixture of saltcake and sludge. After the wastes have been retrieved from sound tanks, the process should move to assumed-to-have-leaked tanks containing saltcake, followed by assumed-to-have-leaked tanks containing salt sludges, and then to known-to-have-leaked SSTs containing waste. By this time, experience with SST retrieval will be quite high so it should not matter whether the tanks contain low or high levels of mobile, long-lived radionuclides. To ensure that there is sufficient feed for HLW immobilization processing, some early sludge retrieval may be needed. The SST retrieval sequence categories are described in Section 5.2.1. The reason for focusing on saltcake tanks is that there is a lot of saltcake waste, it is expected that the use of liquids during retrieval can be closely controlled (relative to the amount of free liquid available for leaking into the vadose zone during retrieval), and it is expected not to require major time or money investments.

## 2.12 THE MISSION SUMMARY DIAGRAM SCHEDULE

The Mission Summary Diagram (MSD) (see Section 3.2, Figures 3.2-1 and 3.2-2) is a graphical representation of the feed delivery plans, supporting activities, and project schedules. The feed staging portion of the MSD uses feed delivery transfer dates obtained from an HTWOS model run. Retrieval and transfer system operational need dates were determined from considerations of the vitrification process duration(s), waste certification duration(s), a desired minimum schedule float, and an acceptable waste backup strategy. Project schedules were provided by the Projects organization. Input took into account baseline project durations and integration of field activities. Intermediate activities, such as waste certification and feed staging transfers, are placed on the diagram to obtain a desired amount of float in the schedule or on the basis of projected transfer dates from HTWOS. Activities and programmatic float are adjusted to resolve conflicts or to maintain contract schedule constraints, where necessary.

The following are examples of general schedule constraints or assumptions used to prepare the MSD. Any specific schedule constraints or assumptions beyond these are identified on the MSD or in the bases and assumptions in Appendix A.

– Provide a minimum of six months of float before and after waste certification (12 months total). This is a preliminary assumption of the float necessary to achieve an 80 percent probability of success.

- Feed delivery transfers occur within a two-month window. This window was negotiated in preparing interface control documents (ICDs) for the feed delivery process.

- BNFL Inc. pretreatment requires one month (one-month lag between completion of the first batch feed delivery window and the waste vitrification process bar). This approximation is based on conversations with BNFL Inc. technical staff.

- The certification of waste in a subsequent feed source or staging tank must be completed on or before the first batch transfer date of the prior tank to have the waste in the subsequent tank available as backup feed.

- When waste from one tank is staged into two tanks, the lag time between certification of waste in both tanks is equal to the time required to vitrify the waste from the first staging tank (of the two) delivered to BNFL Inc. An example is tank 241-AN-104. This is a simplifying assumption for planning purposes.

- Waste certification cannot be completed more than two years before the first batch of waste is delivered to BNFL Inc. This constraint was negotiated through the feed delivery certification process.

- Two-month windows are assumed for each of the following activities, except where noted. These durations were assumed as a starting point for planning.

  - Decanting and degassing

  - Installing mixer pumps

  - Decanting and mixing (eight months are assumed for 241-AN-104)

  - Transferring waste from a source tank to an intermediate waste feed staging tank

A three-month window is assumed for the clean out of tank 241-AN-101.